US006747646B2

(12) **United States Patent**
Gueziec et al.

(10) **Patent No.: US 6,747,646 B2**
(45) **Date of Patent: Jun. 8, 2004**

(54) **SYSTEM AND METHOD FOR FUSING THREE-DIMENSIONAL SHAPE DATA ON DISTORTED IMAGES WITHOUT CORRECTING FOR DISTORTION**

(75) Inventors: **Andre Gueziec**, Mamaroneck, NY (US); **Alan David Kalvin**, Irvington, NY (US); **Willie Williamson, Jr.**, Roseville, CA (US); **Kenong Wu**, Davis, CA (US)

(73) Assignee: **International Business Machines Corporation**, Armonk, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 573 days.

(21) Appl. No.: **09/852,739**

(22) Filed: **May 11, 2001**

(65) **Prior Publication Data**

US 2001/0021806 A1 Sep. 13, 2001

Related U.S. Application Data

(62) Division of application No. 09/354,800, filed on Jul. 16, 1999, now Pat. No. 6,415,171.

(51) **Int. Cl.**[7] **G06T 15/00**
(52) **U.S. Cl.** **345/426**; 345/420; 345/424; 345/629
(58) **Field of Search** 345/419, 420, 345/424, 426, 629, 634, 639; 600/407, 425; 378/207, 42; 382/285, 294, 132; 715/532; 128/897, 922; 700/245; 606/130; 623/908; 706/924

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,299,288 A * 3/1994 Glassman et al. 700/245
5,445,166 A * 8/1995 Taylor 128/897
5,568,384 A * 10/1996 Robb et al. 715/532
5,951,475 A * 9/1999 Gueziec et al. 600/425
6,301,495 B1 * 10/2001 Gueziec et al. 600/407
6,415,171 B1 * 7/2002 Gueziec et al. 600/407

OTHER PUBLICATIONS

Taylor et al., "An overview of computer–integrated surgery at the IBM Thomas J. Watson Research Center", 1996, IBM J. RE Develop. VOL 40 No. 2, pp 163–183.*
Lin et al., "Image Fusion Technique for Head–Neck CT and SPECT Image Registration", 1996.*
Mouravliansky et al., "A New Method for the Elastic Registration of CT and MRI Head Images", 1999, IEEE.*
Maurer, Jr. et al., "Registration of Head CT Images to Physical Space Using a Weighted Combination of Points and Surfaces", 1998, IEEE.*

(List continued on next page.)

Primary Examiner—Almis R. Jankus
(74) *Attorney, Agent, or Firm*—Louis J. Percello, Esq.; McGinn & Gibb, PLLC

(57) **ABSTRACT**

A system and method for intra-operatively providing a surgeon with visual evaluations of possible surgical outcomes ahead of time, and generating simulated data, includes a medical imaging camera, a registration device for registering data to a physical space, and to the medical imaging camera, and a fusion mechanism for fusing the data and the images to generate simulated data, without correcting for distortion. The simulated data (e.g., such as augmented X-ray images) is natural and easy for a surgeon to interpret. In an exemplary implementation, the system preferably includes a data processor which receives a three-dimensional surgical plan or three-dimensional plan of therapy delivery, one or a plurality of two-dimensional intra-operative images, a three-dimensional model of pre-operative data, registration data, and image calibration data. The data processor produces one or a plurality of simulated post-operative images, without correcting for distortion, by integrating a projection of a three-dimensional model of pre-operative data onto one or a plurality of two-dimensional intra-operative images.

26 Claims, 4 Drawing Sheets